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U.S. Department of Transportation
National Highway Traffic Safety Administration

Memorandum

Vehicle Research and Test Center

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Subject: INFORMATION REPORT
CRABI 12-month-old Dummy Evaluation: Sled Series 3

Date: APR 24 2000

From: Roger A. Saul, Ph.D.
Chief, Pedestrian and **Applied Biomechanics Division**

Reply to Attn. of:

To: Docket NHTSA-~~1999-5156~~ 00-7052-5

Thru: **Frank Seales**
Chief Counsel

The attached information report describes a series of sled tests conducted with the 12 month **CRABI** dummy. These tests document the response and durability of the dummy in a representative child seat environment.

Attachment

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CRABI 12-Month-Old Dummy Evaluation: Sled Series 3

July, 1999

Alena V. Hagedorn Transportation Research Center Inc.
Howard B. Pritz, Vehicle Research and Test Center, NHTSA

Purpose

This report documents seven additional sled tests that were done as part of the evaluation of the CRABI 12-month-old Infant Dummy. The purpose of these tests was to look further at the response and durability of the dummy in a representative child seat environment.

The initial evaluation of this CRABI 12-month-old Infant Dummy is described in a report titled, "Evaluation of the CRABI 12-month-old Infant Dummy and its Comparison with the TNO P-3/4 Dummy," dated February 1999. The report has been docketed as NHTSA-1999-5156-6.

Test Matrix

The matrix for the seven tests is presented in Table 1. Tests 3, 4, 6, and 7 were used for the analysis. Tests 1, 2, and 5 were not used because of inconsistencies in the setup or data collection difficulties.

Table 1. CRABI Sled Test Matrix for Sled Series 3

Test Number	Child Seat	Number of CRABI's per Test	Seat Orientation	Air Bag
1*	Fisher Price Safe Embrace: 5 point harness with top tether	2	Front	N
2*		2	Front	N
3		2	Front	N
4		2	Front	N
5*		2	Front	N
6		2	Front	N
7		2	Front	N

* These tests were eliminated from data analysis due to inconsistencies in test setups, etc.

Sled Test Setup

The sled tests were conducted according to the procedures of the previous sled tests (Docket No. NHTSA-1999-5156-6), except that a Fisher Price Safe Embrace child safety seat with a 5-point-

harness and top tether was utilized. Two CRABI 12-month old dummies were used per test. CRABI Dummy Serial Number #011 was placed on one side of the bench seat (position 1). CRABI Dummy Serial Number #025 was positioned on the other side of the bench seat (position 2).

An FMVSS 213 sled buck with the standard FMVSS 213 pulse was utilized. However, strict adherence to FMVSS certification test procedures was not observed since these tests were used for evaluative efforts rather than certification purposes. For example, the FMVSS 213 certification test requires that the foam be compression-tested prior to each sled test and that a specific type of belt webbing is utilized with belts being changed each time. It also mandates a 12 hour recovery period for the foam before compression tests. However, these requirements were not followed in these tests.

The child seat was configured as a forward facing restraint (eg. straps were in the top slot on the back of the child seat and recline adjuster on the seat was down in the "full upright" position), The 5-point-harness buckle was positioned at armpit level. The 5-point-harness was tensioned to allow one finger of slack under the child seat (5-point-belt) straps. The tension of the seat belt was set between 12-15 lbs. Tether tension was also adjusted to this level.

Each CRABI dummy was instrumented as indicated in Table 2. Shoulder load cells and pubic load cells were only available for one dummy (#025). All data presented in this report follows the SAE-J211 sign convention for polarity.

Table 2. CRABI Data Channels for Sled Series 3

Channel	CRABI #011	CRABI #025
Head accel. (X, Y, Z_1, Z_2)	X	X
Chest accel. (X, Y, Z)	X	X
Pelvis accel. (X, Y, Z)	X	X
Upper neck loads (FX, FY, FZ, MX, MY, MZ)	X	X
Lower neck loads (FX, FY, FZ, MX, MY, MZ)	X	X
Lower spine loads (FX, FY, FZ, MX, MY, MZ)	X	X
Left and right Shoulder loads (FX and FZ on each side)		X
Pubic loads (FX and FZ)		X
TOTAL CHANNELS	**28**	**34**

Test Results

Peak values from Tests 3, 4, 6, and 7 are given in Tables 3 - 5. Plots for channels of interest, including resultant accelerations in the head, chest, and pelvis, as well as shear forces, tensile forces, and Y moments for the neck and lumbar spine, are given in the Appendix.

Table 3. Peak values for CRABI #011
Sled Tests Series 3
Fisher Price Safe Embrace Child Seat: 5 point harness with tether

Test #		3	4	6	7
TRC Test #		TRC949	TRC950	TRC952	TRC953
HIC 36msec		368	432	426	402
HIC 15 msec		226	248	246	248
Head X	G	-28.7	-26.4	-26.6	-27.7
Head Z	G	49.8	49.2	46.3	52.3
Head Res.	G	51.8	52.2	51.3	55.2
Head Excursion	mm	573.8	572.8	583.9	567.9
Up Neck Fx	N	-612.1	-577.3	-572.5	-577.0
Up Neck Fz	N	1397.4	1353.2	1352.1	1444.0
Up Neck My +	Nm	12.3	9.5	9.4	12.6
Up Neck My-	Nm	-10.4	-11.5	-10.8	-11.9
Low Neck Fx	N	-963.8	-1035.5	-951.2	-1001.3
Low Neck Fz	N	765.4	738.7	594.9	784.7
Low Neck My	Nm	64.3	62.6	59.4	57.8
Neck MYoc+	Nm	15.1	11.8	11.9	14.9
Neck MYoc-	Nm	-8.2	-8.8	-8.5	-9.1
Chest X.	G	-46.2	-46.9	-50.1	-50.2
Chest Z	G	-29.0	-24.8	-23.3	-21.1
Chest Res	G	53.5	50.1	52.2	52.0
Chest 3 msec Clip		50.8	49.0	51.5	51.0
Pelvis X.	G	-58.3	-52.4	-47.9	-49.0
Pelvis Z	G	-46.2	-48.8	-49.4	-45.0
Pelvis Res.	G	67.5	65.9	67.3	64.2
Low Spine Fx	N	615.3	821.7	823.4	642.0
Low Spine Fz	N	-1646.4	-1478.7	-1538.9	-1503.6
Low Spine My(+)	Nm	-17.7	-15.9	-15.5	-16.9
Pubic Fx	N	NA	NA	NA	NA
Pubic Fz	N	NA	NA	NA	NA

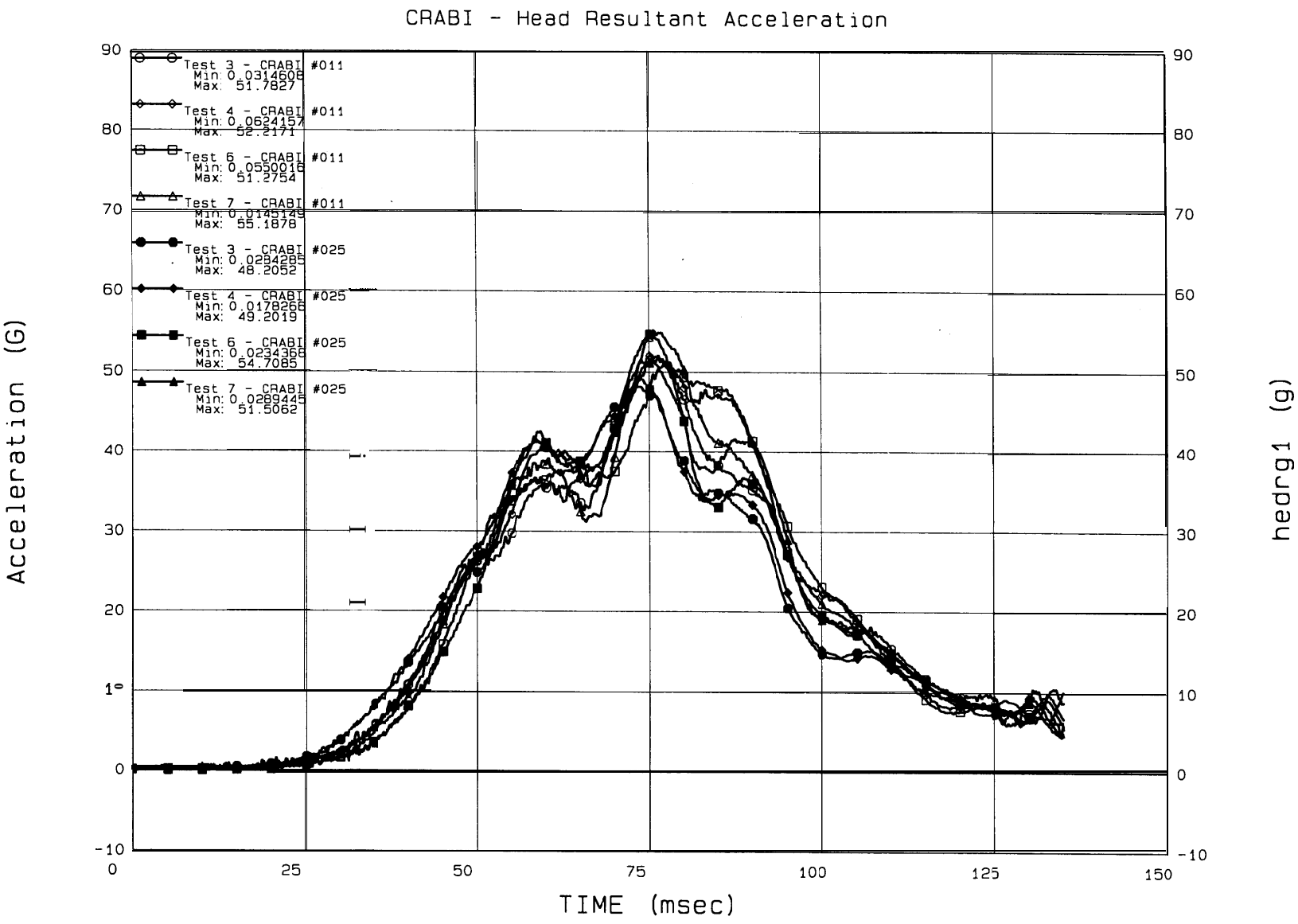
Table 4. Peak values for CRABI #025
Sled Tests Series 3
Fisher Price Safe Embrace Child Seat: 5 point harness with tether

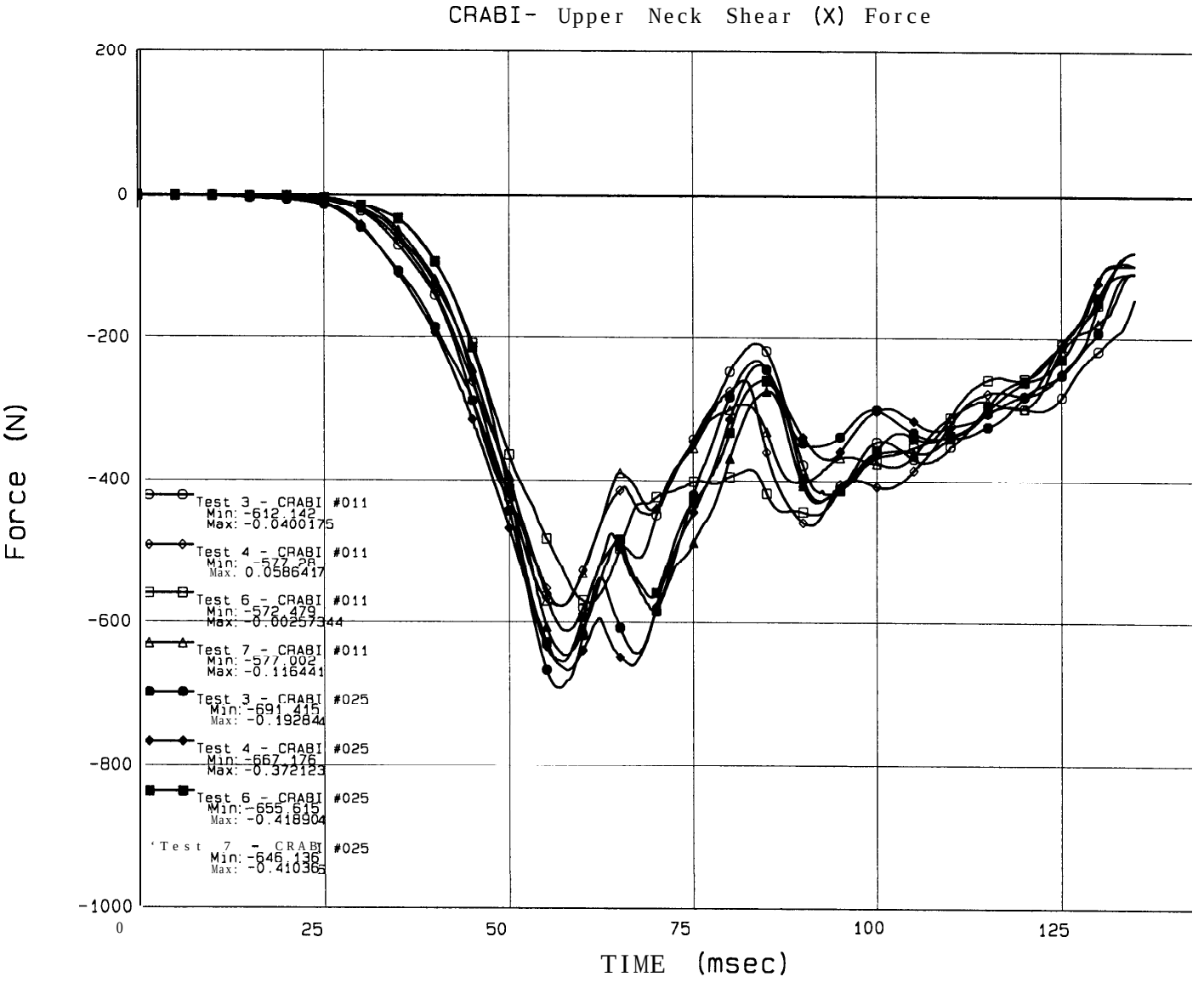
Test #		3	4	6	7
TRC Test #		TRC949	TRC950	TRC952	TRC953
HIC 36msec		362	364	399	399
HIC 15 msec		195	193	227	205
Head X	G	-36.2	-37.5	-30.1	-32.7
Head Z	G	42.3	42.3	49.4	44.2
Head Res.	G	48.2	49.2	54.7	51.5
Head Excursion	mm	549.9	550.2	576.1	575.8
Up Neck Fx	N	-691.4	-667.2	-655.6	-646.1
Up Neck Fz	N	1373.6	1383.6	1553.6	1426.7
Up Neck My +	Nm	14.7	15.1	13.1	12.1
Up Neck My-	Nm	-10.9	-10.5	-15.1	-13.5
Low Neck Fx	N	-880.4	-979.3	-1079.7	-994.6
Low Neck Fz	N	572.7	565.6	602.7	585.4
Low Neck My	Nm	76.7	76.6	71.6	69.3
Neck MYoc+	Nm	18.3	18.9	16.3	15.3
Neck MYoc-	Nm	-7..4	-7.6	-11.7	-10.3
Chest X.	G	-49.0	-45.7	-53.8	-54.3
Chest Z	G	-28.6	-24.6	-22.5	-23.0
Chest Res	G	56.6	50.7	56.2	57.9
Chest 3 msec Clip		53.1	49.5	53.1	53.2
Pelvis X.	G	-55.0	-59.7	-60.1	-54.7
Pelvis Z	G	-48.3	-43.1	-43.1	-47.2
Pelvis Res.	G	64.5	71.0	71.4	71.6
Low Spine Fx	N	445.8	468.5	612.1	606.2
Low Spine Fz	N	-1521.8	1696	1675.9	1566.7
Low Spine My	Nm	-	20.2	16.9	-
Pubic Fx	N	-381.5	-524.2	-	-
Pubic Fz	N	-970.9	-1084.8	-990.9	-1050.6

Table 5. Peak values for CRABI #011 and #025
Sled Tests Series 3
Fisher Price Safe Embrace Child Seat: 5 point harness with tether

Test #		3		4		6		7	
TRC Test #		TRC949		TRC950		TRC952		TRC953	
Dummy Number		011	025	011	025	011	025	011	025
HIC 36msec		368	362	432	364	426	399	402	399
HIC 15 msec		226	195	248	193	246	227	248	205
Head X	G	28.7	36.2	26.4	37.5	26.6	30.I	27.7	32.7
Head Z	G	49.8	42.3	49.2	42.3	46.3	49.4	52.3	44.2
Head Res.	G	51.8	48.2	52.2	49.2	51.3	54.7	55.2	51.5
Head Excursion	mm	573.8	549.9	572.8	550.2	583.9	576.1	567.9	575.8
Up Neck Fx	N	-612.1	691.4	577.3	667.2	572.5	655.6	577.0	646.1
Up Neck Fz	N	1397.4	1373.6	1353.2	1383.6	1352.1	1553.6	1444.0	1426.7
Up Neck My +	Nm	12.3	14.7	9.5	15.1	9.4	13.1	12.6	12.1
Up Neck My-		10.4	10.9	11.5	10.5	10.8	15.1	11.9	13.5
Low Neck Fx	N	963.8	880.4	1035.5	979.3	951.2	1079.7	1001.3	994.6
Low Neck Fz	N	765.4	572.7	738.7	565.6	594.9	602.7	784.7	585.4
Low Neck My	Nm	64.3	76.7	62.6	76.6	59.4	71.6	57.8	69.3
Neck MYoc+	Nm	15.1	18.3	11.8	18.9	11.9	16.3	14.9	15.3
Neck MYoc-	Nm	8.2	7.4	8.8	7.6	8.5	11.7	9.1	10.3
Chest X.	G	46.2	49.0	46.9	45.7	50.1	53.8	50.2	54.3
Chest Z	G	29.0	28.6	24.8	24.6	23.3	22.5	21.1	23.0
Chest Res	G	53.5	56.6	50.1	50.7	52.2	56.2	52.0	57.9
Chest 3 msec	(60	50.8	53.1	49.0	49.5	51.5	53.1	51.0	53.2
Pelvis X.	G	58.3	55.0	-52.4	59.7	47.9	60.1	49.0	54.7
Pelvis Z	G	46.2	48.3	48.8	43.1	49.4	43.1	45.0	47.2
Pelvis Res.	G	67.5	64.5	65.9	71.0	67.3	71.4	64.2	71.6
Low Spine Fx	N	615.3	445.8	821.7	468.5	823.4	612.1	642.0	606.2
Low Spine Fz	N	1646.4	1521.9	1478.7	1696	1538.9	1675.9	1503.6	1566.7
Low Spine My	Nm	-17.7	-18.7	-15.9	-20.2	-15.5	-16.9	-16.9	-16.5

Appendix


CRABI - Head Resultant Acceleration
Test 3 - CRABI #011
Min: 0.0314608
Max: 51.7827
Test 4 - CRABI #011
Min: 0.0624157
Max: 52.2171
Test 6 - CRABI #011
Min: 0.0550016
Max: 51.2754
Test 7 - CRABI #011
Min: 0.0145149
Max: 55.1878
Test 3 - CRABI #025
Min: 0.0284285
Max: 48.2052
Test 4 - CRABI #025
Min: 0.0178266
Max: 49.2019
Test 6 - CRABI #025
Min: 0.0234366
Max: 54.7085
Test 7 - CRABI #025
Min: 0.0289445
Max: 51.5062
Acceleration (G)
hedrg1 (g)
TIME (msec)
90
80
70
60
50
40
30
20
10
0
-10
0
25
50
75
100
125
150


CRABI- Upper Neck Shear (X) Force
200
0
-200
-400
-600
-800
-1000
Force (N)
0
25
50
75
100
125
TIME (msec)
Test 3 - CRABI #011
Min: -612.142
Max: -0.0400175
Test 4 - CRABI #011
Min: -577.28
Max: 0.0586417
Test 6 - CRABI #011
Min: -572.479
Max: -0.00257344
Test 7 - CRABI #011
Min: -577.002
Max: -0.116441
Test 3 - CRABI #025
Min: -691.415
Max: -0.192844
Test 4 - CRABI #025
Min: -667.176
Max: -0.372123
Test 6 - CRABI #025
Min: -655.615
Max: -0.418904
Test 7 - CRABI #025
Min: -646.136
Max: -0.410365

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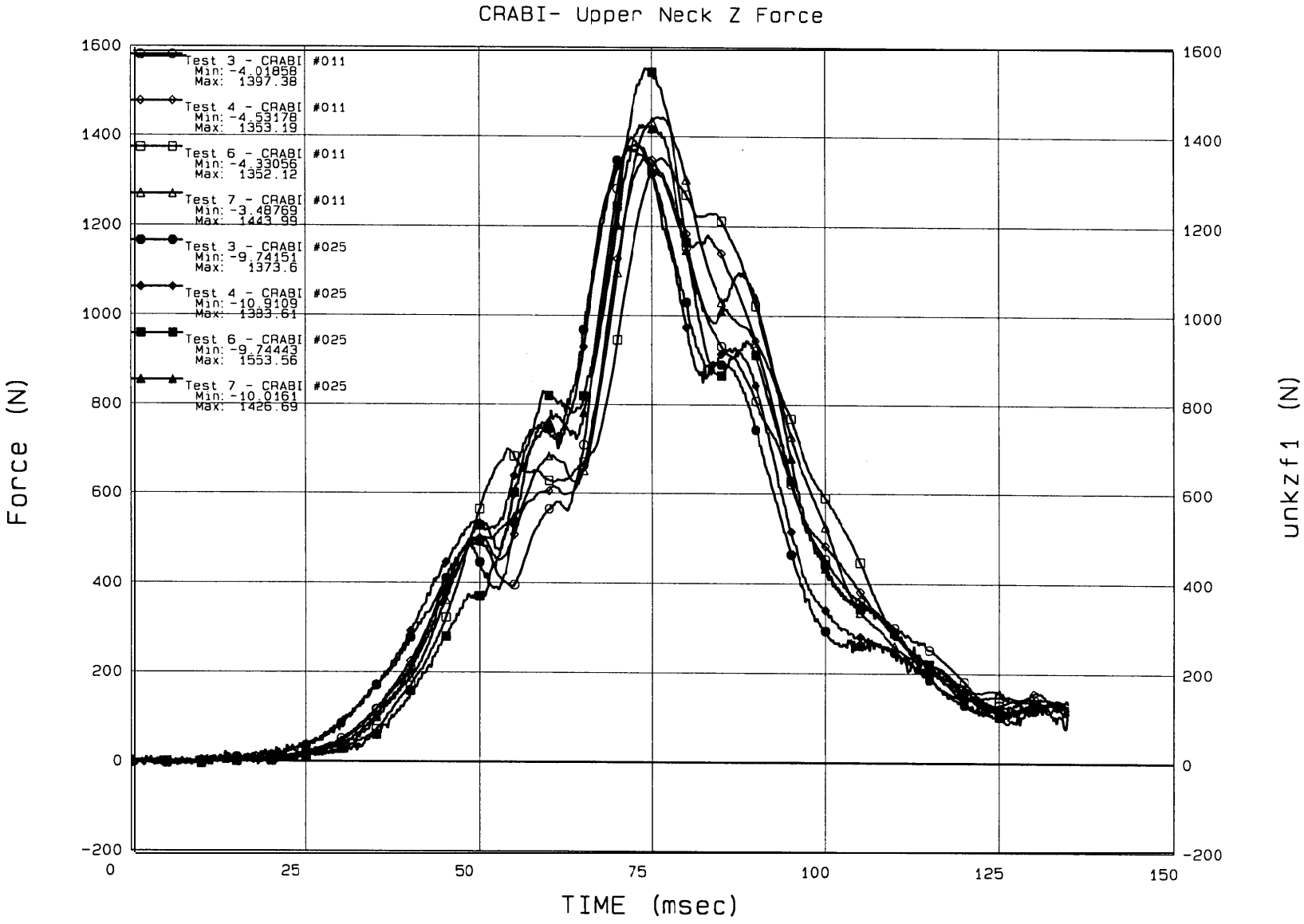

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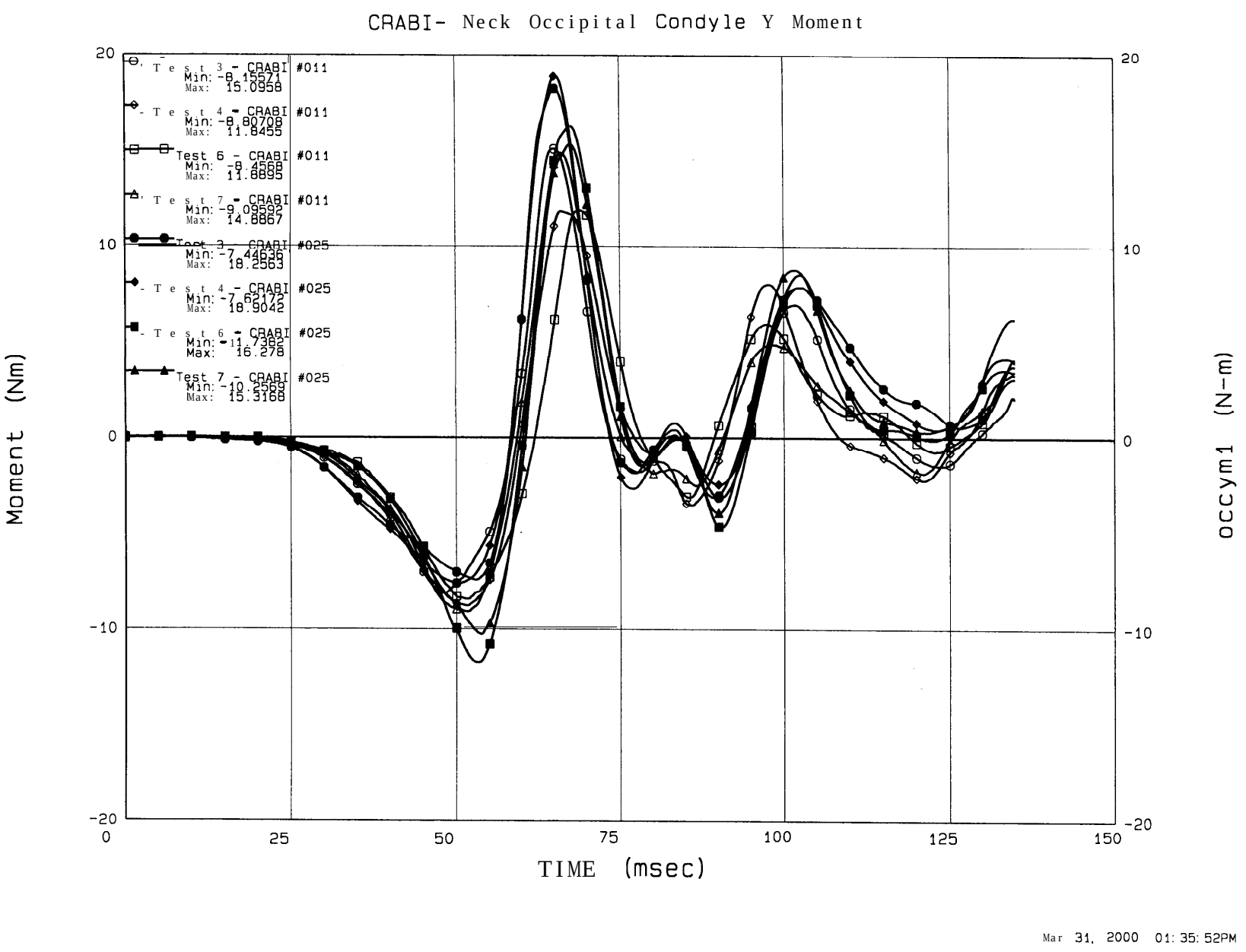

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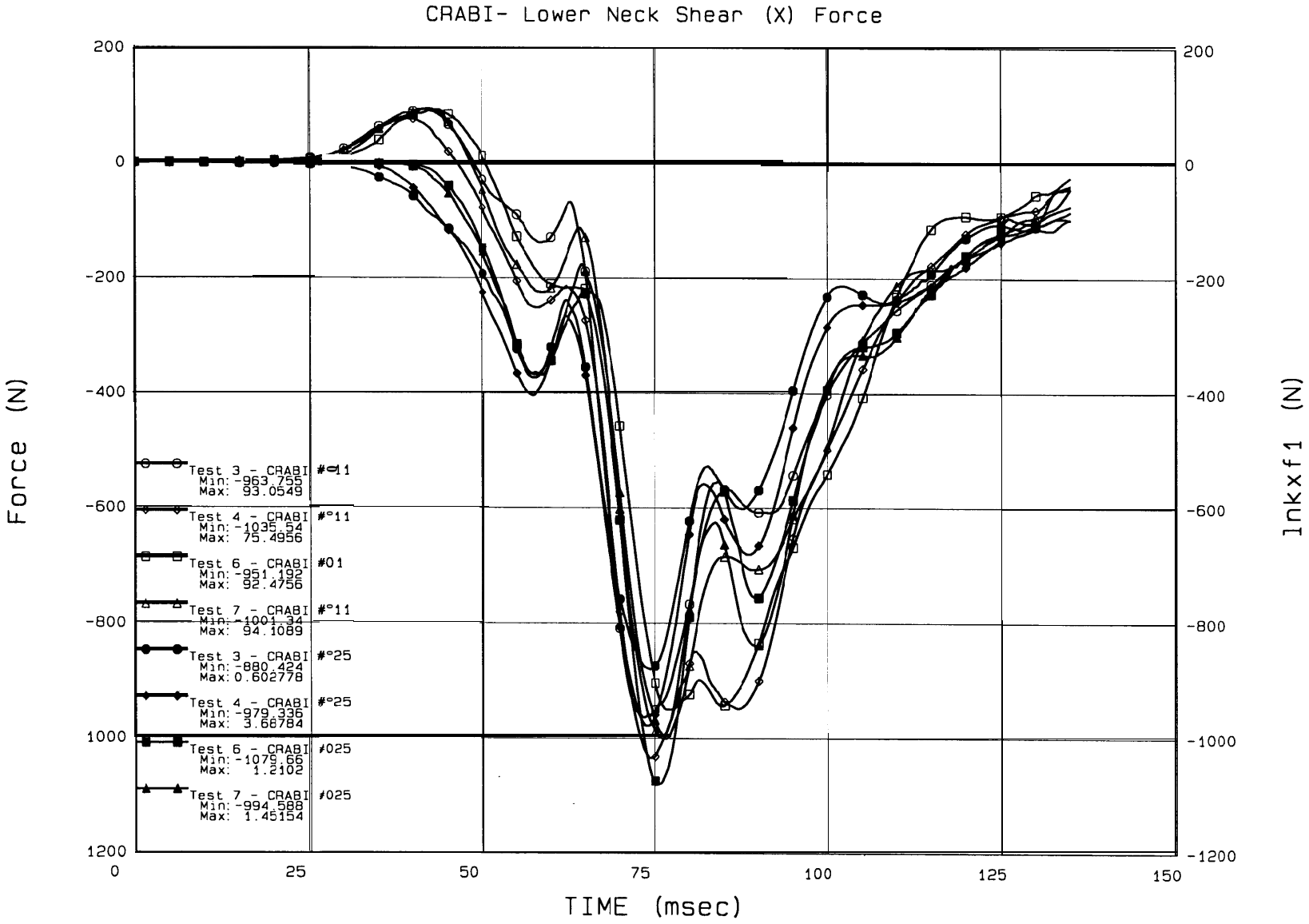

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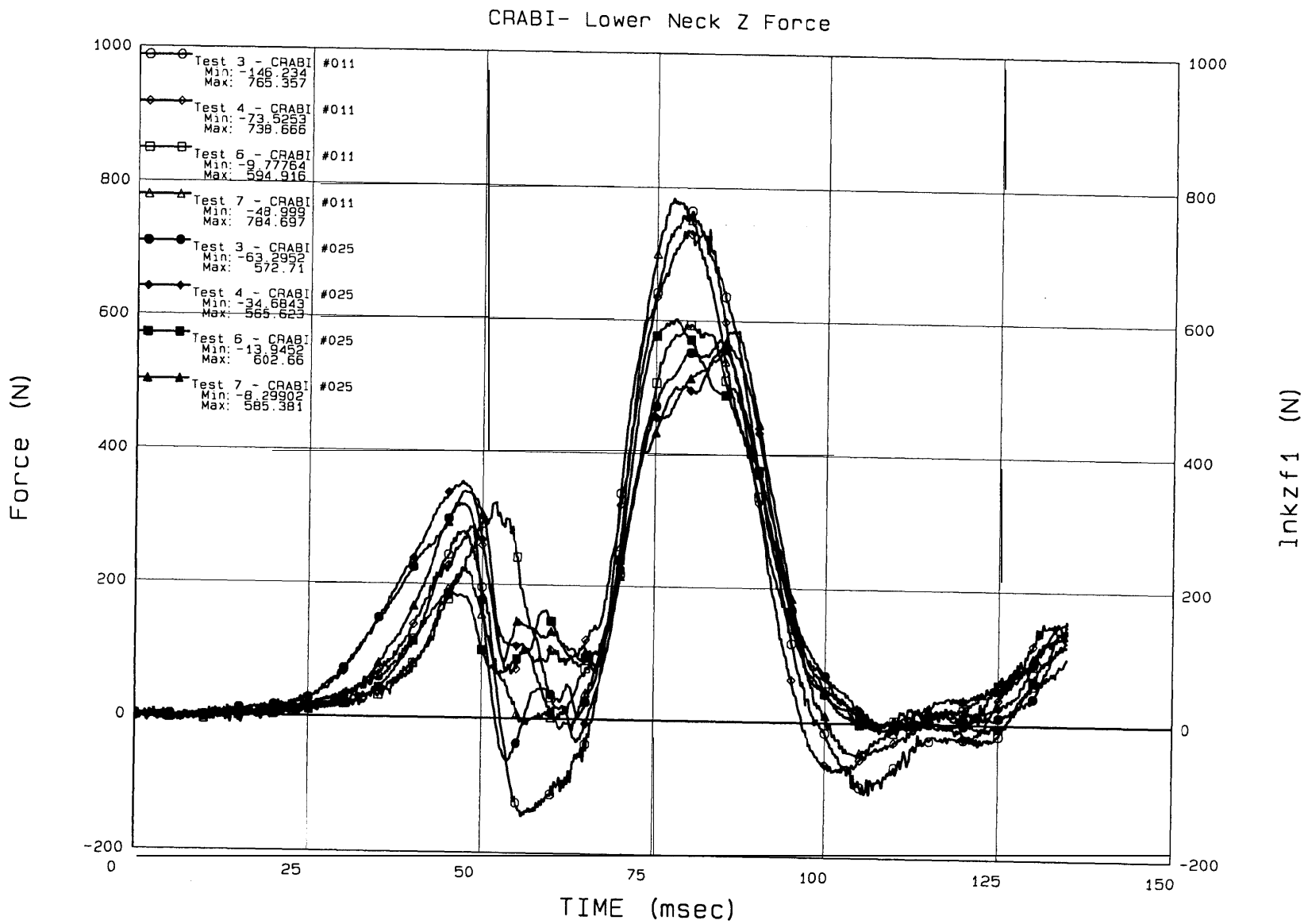
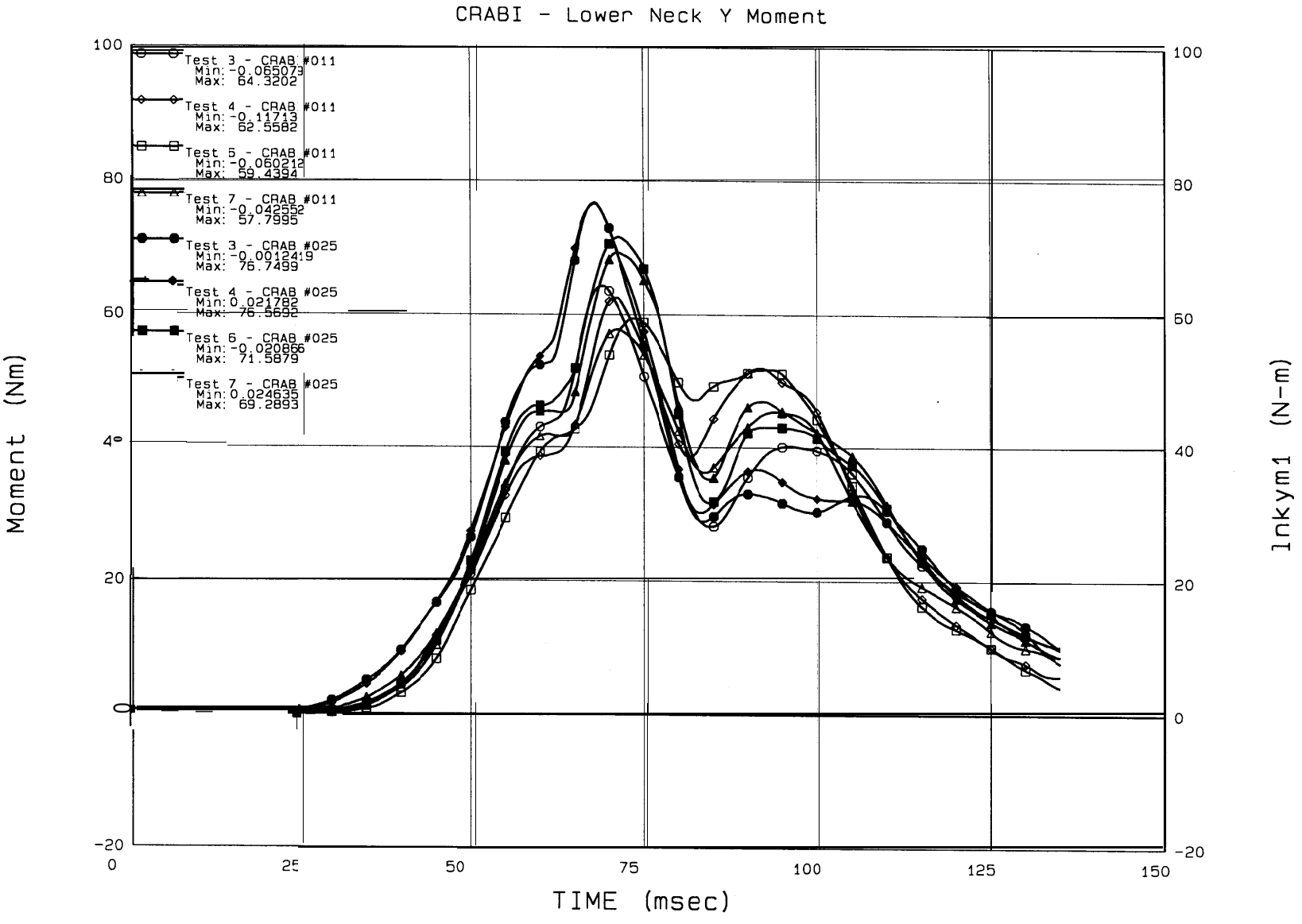
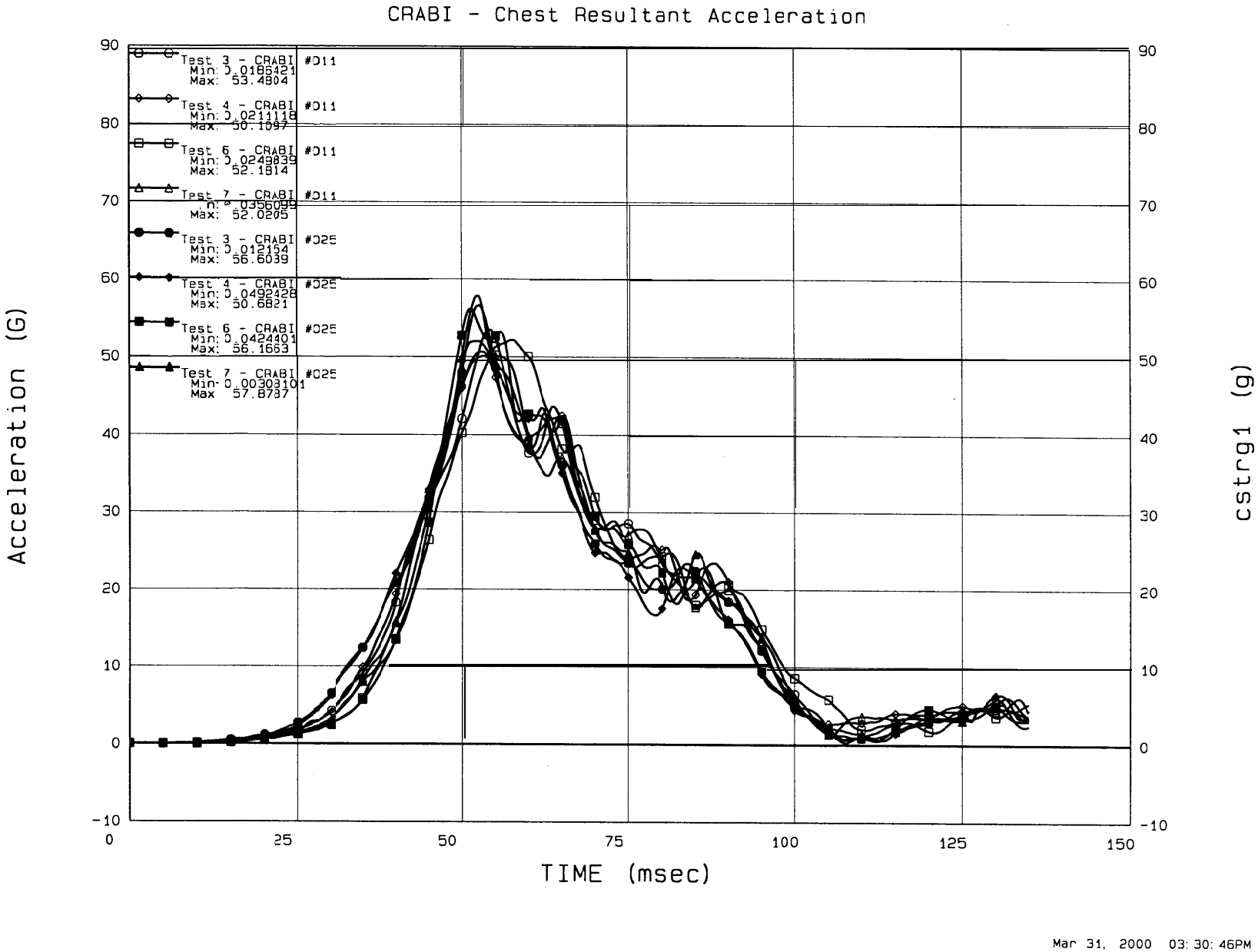

CRABI- Lower Neck Z Force
Test 3 - CRABI #011
Min: -146.234
Max: 765.357
Test 4 - CRABI #011
Min: -73.5253
Max: 738.666
Test 6 - CRABI #011
Min: -9.77764
Max: 594.916
Test 7 - CRABI #011
Min: -48.999
Max: 784.697
Test 3 - CRABI #025
Min: -63.2952
Max: 572.71
Test 4 - CRABI #025
Min: -34.6843
Max: 565.623
Test 6 - CRABI #025
Min: -13.9452
Max: 602.66
Test 7 - CRABI #025
Min: -8.29902
Max: 585.381
Force (N)
lnkzf1 (N)
TIME (msec)
1000
800
600
400
200
0
-200
0
25
50
75
100
125
150


CRABI - Lower Neck Y Moment
Test 3 - CRAB #011
Min: -0.065073
Max: 64.3202
Test 4 - CRAB #011
Min: -0.11713
Max: 62.5582
Test 5 - CRAB #011
Min: -0.060212
Max: 59.4394
Test 7 - CRAB #011
Min: -0.042552
Max: 57.7995
Test 3 - CRAB #025
Min: -0.0012419
Max: 76.7499
Test 4 - CRAB #025
Min: 0.021782
Max: 76.5692
Test 6 - CRAB #025
Min: -0.020866
Max: 71.5879
Test 7 - CRAB #025
Min: 0.024635
Max: 69.2893
Moment (Nm)
Inkym1 (N-m)
TIME (msec)
100
80
60
40
20
0
-20
0
25
50
75
100
125
150



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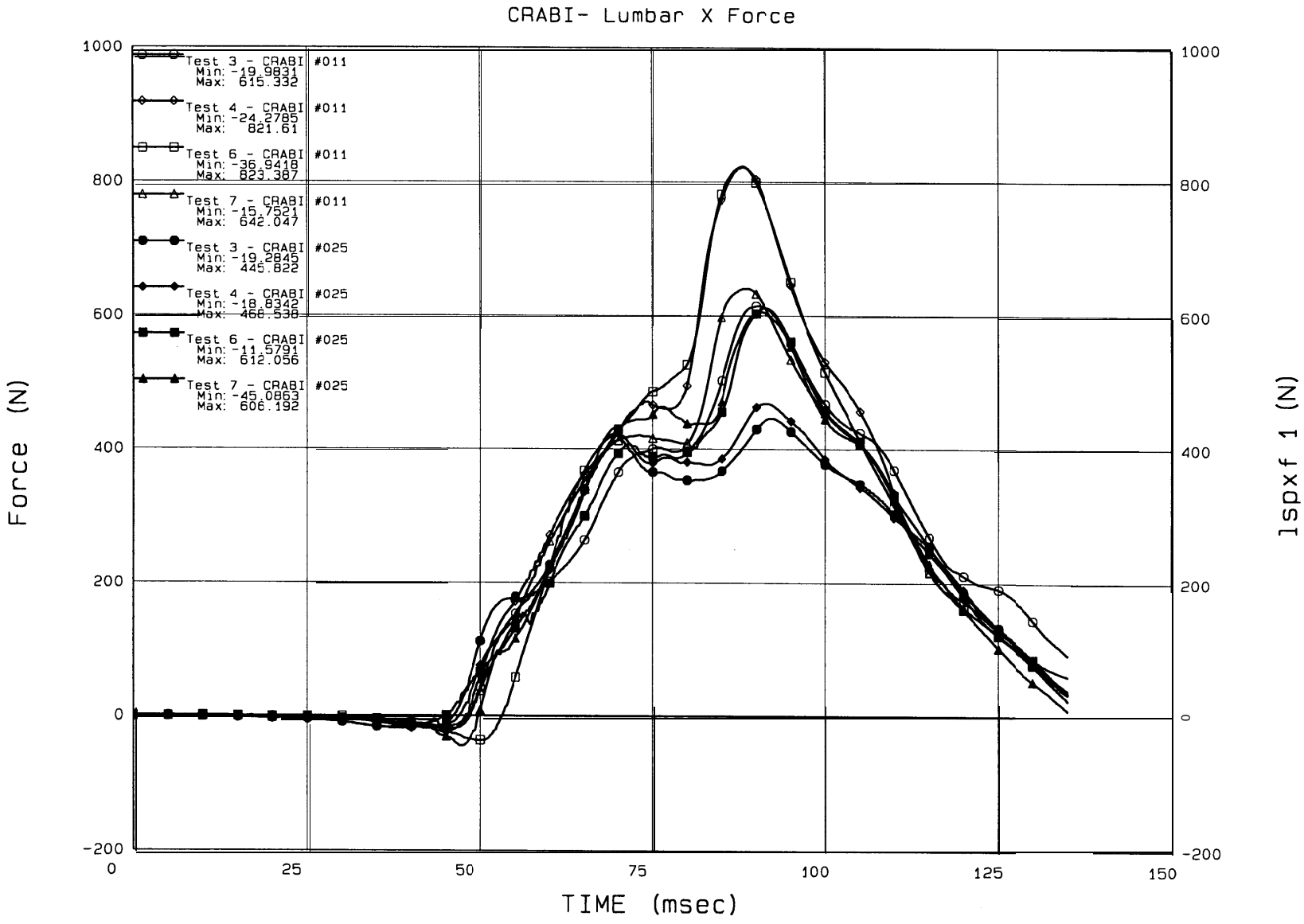

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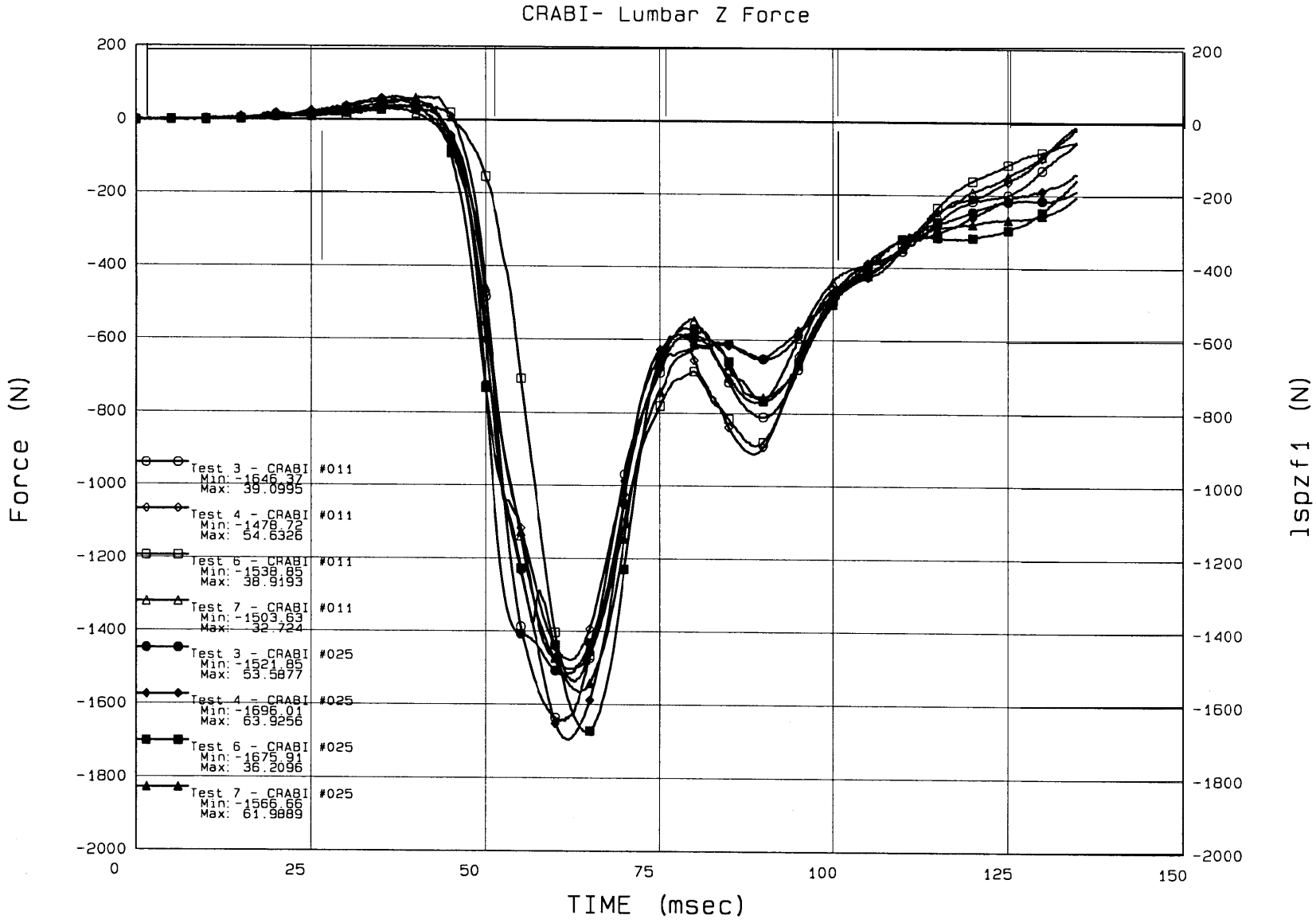

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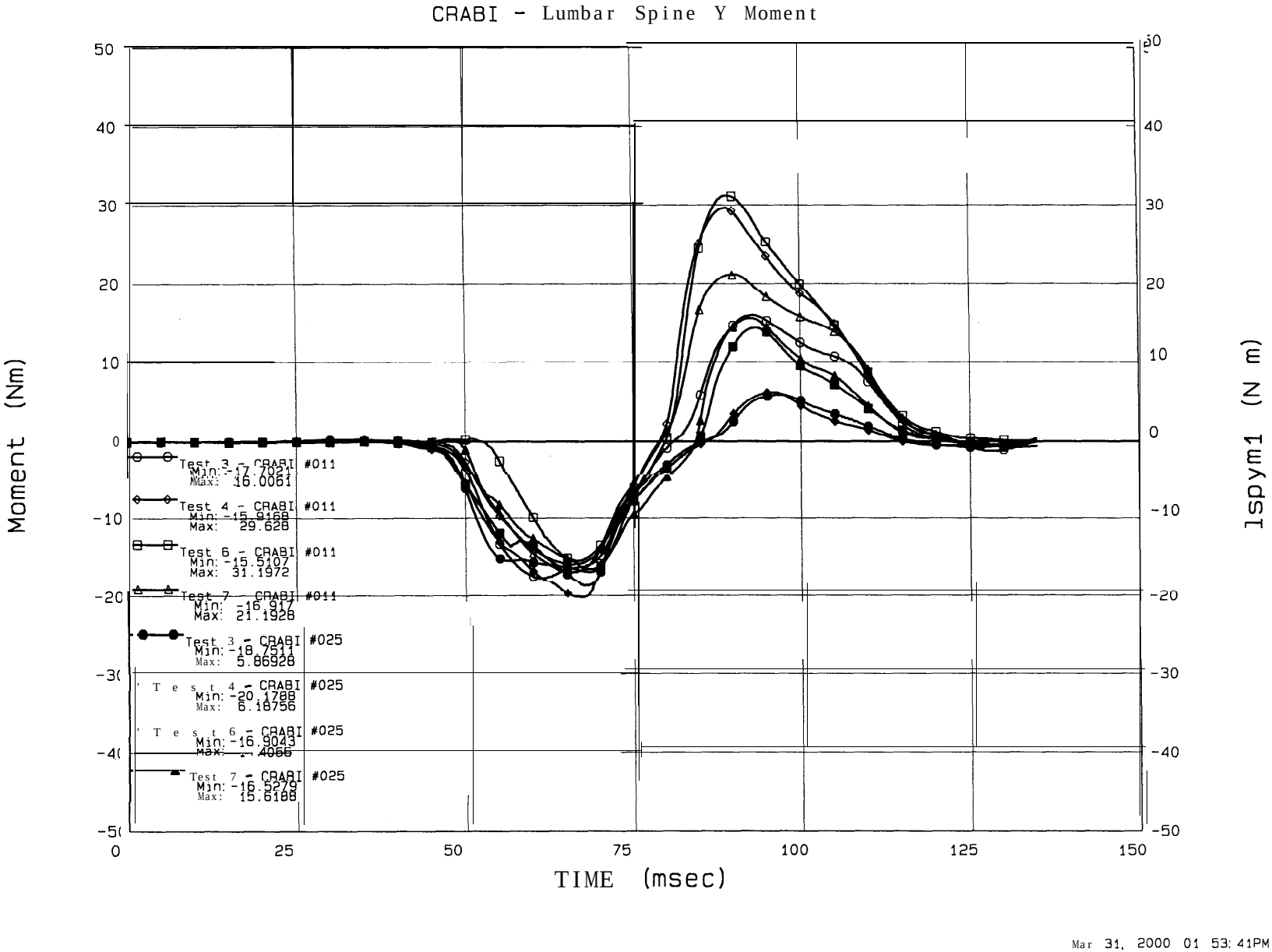

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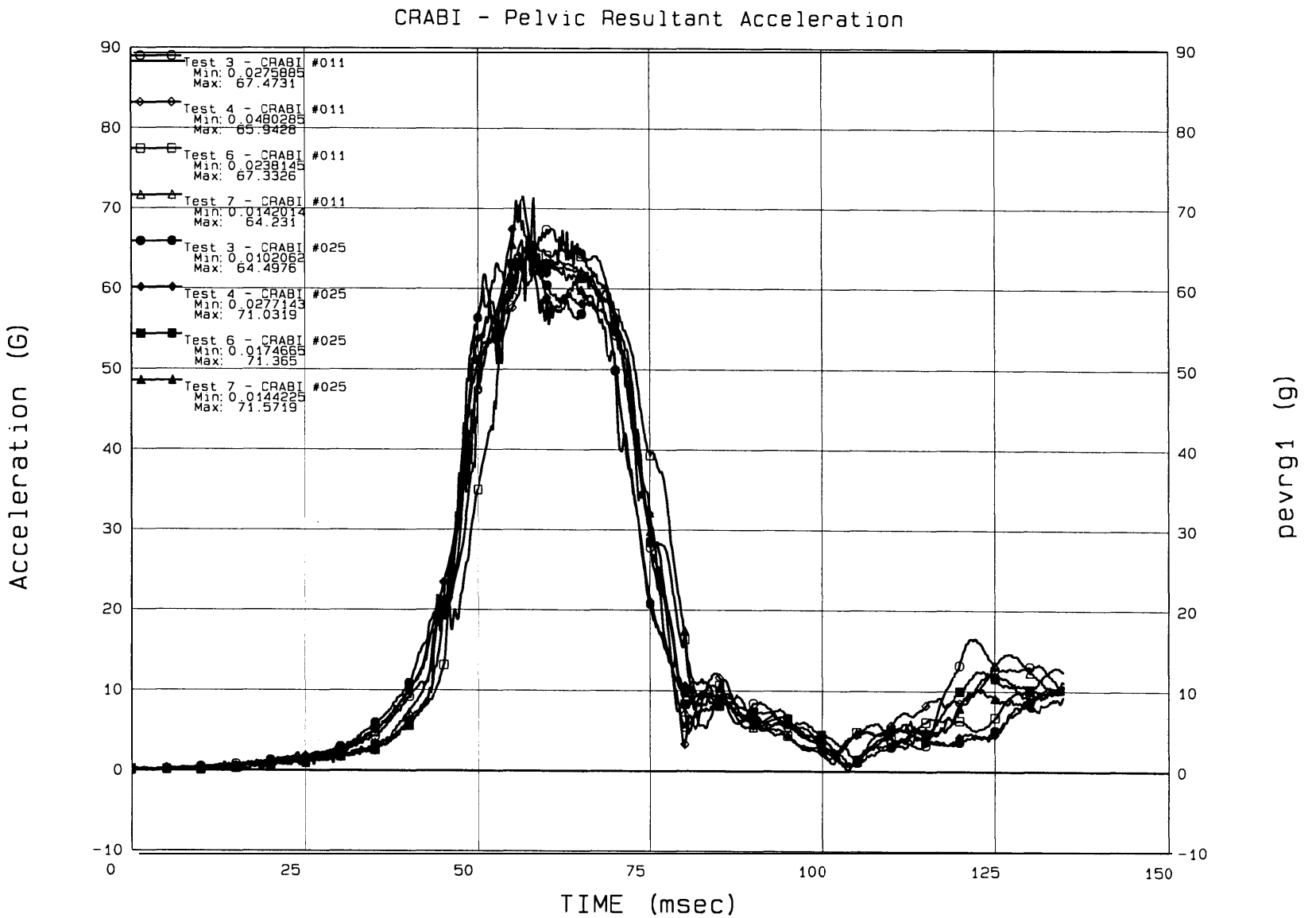

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